Managerial strategies in canning industries: A case study of early twentieth century Portugal

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The paper discusses entry barriers in the Portuguese canning industries in the early twentieth century. The most important challenge facing the canning industries was a dependence on unsteady supply of raw material. The available technology, branding trademarks, product differentiation and product quality, versus abundance or scarcity of resources to be used as inputs and international trade presented contradictory effects on entry barriers. Deterrence was inefficient, some foreign firms delocalised to Portugal, and the sector is an interesting case-study in the historical context of globalisation.

Keywords: canning industries; Portugal; entry-barrier effects; deterrence factors; managerial abilities; branding; vertical integration; environmental history

According to microeconomics, whenever ongoing producers can enjoy absolute advantages in costs of production, scale economies and industrial concentration will occur and represent high barriers to new producers' entry (Bain, 1956; Ferguson, 1974). In fact, newcomers cannot compete with the ongoing units. At the same time, established trademarks are very well-known and consumer loyalty is an important factor in market sharing, as reputation generates the consumers' confidence in the product and loyalty to it. Product differentiation also adds the flavour of monopolistic competition to the market, also bringing difficulties to new entrants (Demsetz, 1982, pp. 47–57). This paper is an empirical study of the contradictory effects of some variables on entry barriers to newcomers and industrial concentration in the nineteenth-century canning industry in Portugal, stressing the role of abundance and location of raw material. Portuguese food industries in the beginning of the twentieth century canned foods such as fish, meat, tomatoes, mixed vegetables and various fruits.[1] The main challenge faced by canning industries was the unsteady provision of raw materials. Vegetable crops had (and still have today) a seasonal character and were subject to climatic conditions. Domestic markets were traditionally provided with fresh fish, which left its imprint on the Portuguese eating habits. Fish consumption and canning depended on the success of fishing. Raw-material provision for canning industries was in competition with fresh provision to consumption markets and extended the demand

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even more. If raw material was such a vulnerable variable, it seems possible to propose that producers who could provision their units would enlarge production, benefit from economies of scale and raise barriers against new entrants. This is a very well-known sector in the Portuguese literature, because of its positive contribution to the Portuguese trade balance (Barbosa, 1941; Salazar, 1935). However, its beginnings in the last decades of the nineteenth century are not studied, and this paper aims to show how contradictory effects in terms of entry barriers prevailed in this sector (for the codfish drying industry see Garrido, 2003). How did technology affect this course of events? Did producers register their trademarks and differentiate their produce at the same time? Did they try to increase their market shares in advertising their products? How can we explain such a diversified presentation for the produce in the markets? Was vertical concentration the path to success in this business, contributing to oligopolistic features in this market?

This paper deals with the notion that although entry barriers may exist because of most of these factors, and it is useful to study their consequences in terms of the market equilibrium, one cannot forget that markets sometimes tend to cancel deterrence effects and entry barriers in the presence of abundantly located raw material and international trade (Caves & Porter, 1977; Demsetz, 1982). The goal is to demonstrate the importance of international demand and European newcomers in blurring entry barriers in the long run, in a historical context of international market and globalisation.

Fish-canning technologies and managerial decisions

The country developed a specialisation in canning fish, because the Portuguese mainland territory has a long seacoast. Tuna was available on the Southern coast as schools went to the Mediterranean Sea to spawn, and sardines were plentiful. The perishable character of the raw material was a problem, since refrigeration was not yet available. This meant that industrial manipulation had to occur in a short period of time in order to preserve food quality and freshness. Consumer preferences, health and safety depended on this factor, because among all food raw materials fish is the most perishable. Quality greatly depended on a fresh smell and taste, so the location of fish-canning factories was necessarily near the sea. The advantages of this location are obvious: it reduced transportation costs and saved time. A distance from the sea of more than three hours was too far for a factory location, as the canning procedure in the factory took several hours until the fish was safely preserved. For these reasons factories stretched along the southern coast (in small towns such as Olhão, Albufeira, Lagos and Portimão) and along the western coast (in cities such as Setúbal, Sesimbra, Lisbon, Figueira da Foz, Espinho and Matosinhos). Figure 1 shows these Portuguese fishing harbours.

Fish-canning factories usually included many large sheds and consequently required a good deal of space. The roofs of the sheds were covered with tiles, to be cool in the summer and thus provide better preservation conditions. The floor needed to be cleaned and washed frequently because of the smell. Waste water was drained off into the sea.

A regular supply of fish was a main concern in order to avoid breaks in the production chain or over-time production, both of which were costly. Moreover, work by night required extra wages and illuminated factories. To benefit from abundant raw material in the fish-canning industries new technologies were required and higher entrance costs

Figure 1. Map of Portugal.

incurred, as only some factories could use gas illumination (and others electricity). Technological upgrades could reward high investment and may be analysed as a competitive behaviour against other less sophisticated producers or newcomers. The small factories were less modern, poorly illuminated and could not reap economies of scale. The idea was to buy the fish early in the morning at the seaports, as fishing boats left late at night and returned early in the morning. At times they might return late, as they only came back when the catch was complete. This, too, could lead to a disruption in the factory work.

Harbours themselves were the fish markets. Fishing managers sold a boat's entire catch as a unit, and canners purchased according to their needs. The equilibrium price resulted from market forces, the demand and supply, and the abundance versus the pressing need of raw material. When resources are abundant for all producers, there are no entry barriers (Stigler, 1968). However, this was an auction market, curiously a 'Dutch' auction market: fishing managers auctioned off their cargoes departing from a prohibitive price level and gradually reducing the asking price until someone in the audience interrupted them in order to buy. It is possible to assume that larger canning operators could perform predatory practices, typical of non-cooperative games, both in exhausting raw material and in lowering prices of the final product, in order to kill competition (Bain, 1956).

As fish quality was a decisive factor in the sale, fish were displayed in creels, hampers, or boxes, etc. Crushed or flabby fish would not sell. Dragnet fishing always crushed a large part of the catch, as did transfer to the wharf. Fish were sorted on arrival at the factory, based on government regulations that required a size between 9 and 16 centimetres (crushed and flabby fish were then rejected). Regulations protected consumers from too small or too large fish, which were less tasty, and the lower limit also protected the

reproduction of schools and stocks in order that long-run provision of raw material was sustained.

On arriving at the factory, the first task was cleaning (beheading, disembowelling and washing the fish on large tables). It was a simple labour-intensive task, requiring attention, experience and training. A large amount of water was needed for this phase. It was necessary that factories had systems for water provision and also sinks and systems for draining dirty water into sewers. Hygienic concerns added high entrance costs, as government regulations and inspections were strict and both quality and consumer safety depended on these infrastructures. Scaling the fish was avoided in order to preserve their fresh appearance (and was superfluous, as scales almost disappeared in the canning process).

For skinning, the fish were arranged on flayer grids (in the position they would have in the cans, to avoid too much manipulation and successive creases on the surface – measures to preserve appearance). Flayer grids were fitted into wheeled frames that could run on rails, in order to facilitate their transfer to other sections of the factory. The complexity of the production line is important to consider in examining new entrant possibilities (a case study is available in Dowell, 2006).

A second task was to steam, boil or fry the fish. Entire trays were placed in boiling or frying containers for about three minutes. Steaming was used in the most modern units, which means that technology also created strong pressure on sunk costs and investment. Boiling had to be careful, as it was necessary to preserve the appearance of the fish. Frying provided a better quality and saved time because boiling required a waiting time for all the water to drain from the fish, a very time-consuming process demanding about three hours, if drying chambers were not available. This was also a more capital-intensive process, exhibiting declining average costs.

Superior technology could also be used in the subsequent phase of the canning process, when the fish were put into tin-plated cans, along with olive oil or another vegetable oil. The oil apportionment could be done individually or with a spilling system over the cans. Another technological system consisted of submerging the cans into an oil bath, but only the well-equipped factories had such machinery.

It was then necessary to let the cans rest for some time in order for the oil to seep into the small spaces and drive out any air bubbles, as the presence of air contributed to decomposition or deterioration. The cans were then carefully closed with solder leaving a small lapel to open. The opener keys were soldered to the cans or not, but were always sold with them.

The next phase was sterilisation, which was achieved by boiling the closed cans at high temperatures (on the presence of germs and bacilli see May, 1938, pp. 97–106). Imperfectly sealed cans were detected at this time. It was very important that water had been completely drained from fish, since cans containing water would rupture during the boiling sterilisation, or bulge their surface. It was understood that 'heat serves to fix the small portion of atmospheric oxygen which is present by combining it with some principles in the other substances, so that it was no longer capable of producing the fermentative action, which in parallel cases leads to decomposition' (May, 1938, p. 358).

Factories needed space to store decorated cans, as well as make the cans and to store them. Other sheds were needed to store the materials for making cans and crates. Sterilised cans were packed in wooden crates, which were nailed shut and sashed with metal bands. The interior spaces in the wood box were filled with wood shavings, making use of the carpentry waste. Delivery to domestic markets and shipping abroad completed the production cycle.

One cannot conclude that technological innovation was pursued purposely as an investment to deter new competitors from entry, because not only the investor but all the ongoing factories would become protected and competition (or rivalry) surely recommended collusion strategies (Caves & Porter, 1977, p. 247). Any entry barriers are collective capital goods generating positive externalities. However, more capital-intensive technologies could provide differentials in profits or even interest rate differentials for the invested capital, and survival is always an important asset in markets in producing and capturing the consumers' preference.

Quality and diversified produce as managerial strategies

According to industrial economics, several definitions for entry barriers may be adopted. Although costs and prices are called for in identifying predatory pricing strategies against newcomers, all factors that may make entry an unprofitable operation while existing firms set prices above marginal cost to 'persistently earn a monopoly return' may be seen as deterrence factors (Ferguson 1974, p. 10). Considering that market shares depend not only on scale economies but also on advertising (Schmalensee, 1981), marketing abilities also create asymmetric opportunities against new producers and entrants and may be seen as an entrepreneurial strategy to create entrance barriers (Vernon & Nourse, 1973). The fish cans were painted, representing beautiful ships, elegant ladies, fishes and fishermen, as well as beautiful panoramic sights of Portuguese port cities. Advertising was also a way to create entry barriers because it cements loyalties (Cubbin, 1981). Brands and trademarks were present in the Portuguese canning industry market. They provided character to the produce and promoted confidence among consumers, exhibiting the coloured trademarks registered by the firm. Although new entrants can play a loyalty-winning game, it may happen that firms with the largest market shares could have attained a threshold level of promotion that had an effect on consumers' behaviour while spreading the cost for reaching such a threshold over a larger volume of sales than smaller rivals. Moreover, the strong capital needs of new entrants for technology in a country with small capital markets may have helped the established producers to deter small ones or retard their growth, as smallness means inferior image in comparison with well-known brands, and larger older firms usually borrow more easily than do smaller younger firms (Caves & Porter, 1977, p. 246).

According to the 1880 Industrial Inquiry that the Portuguese Ministry of Public Works, Commerce and Industry organised, 12 factories were devoted to canning in Portugal. Ten years later, the Industrial Inquiry mentions 52 factories. Although Portuguese firms were dominant in the sector, foreign canners came to Portugal and many brands were French, Danish, British or German. As much of the produce was exported, the use of foreign trademarks was even attractive for Portuguese producers, as cans could be introduced to consumers in their own language. Good examples of foreign new entrants are Canaud Sardines, Sanglier, Martin Stock and Carl Wandel, the sardines La Sirène, the firm Veuve Firmin Jullien,[2] Pierre Chancerelle, and Établissements F. Deleroy, headquartered at Lorient (France) and having factories in Setúbal, Lagos and Olhão. The expense of entry is a sunk cost and the expected rate of return was higher if differentiation, product quality or sales promotion expenditures allowed for positive conjectures (Caves & Porter, 1977, p. 243).

The activity introduced by one of these foreign firms that began operating in Portugal, Émile Louis Roullet, founder of the joint stock company Société Générale Française, is described in the petition presented in 1890 to the Portuguese Ministry of Public Works to begin their business in Portugal.[3] Having equity amounting to FF1.2 million in 2400

shares, the company proposed to introduce a technology made of salting containers; baskets for washing; flayers; tables for beheading the fish, stumps and logs; kitchen tables covered by corrugated iron; a steam boiling pan; wood-dryers; pulleys, four copper pans; grids to fry, buckets and zinc pails; tools for joiners and solderers; tables for soldering; oil containers, and traps for rats (*Diário do Governo*, 24 October 1890). A 1907 report of the Portuguese Ministry of Public Works, Commerce and Industry on Lisbon's canning factories refers to the existence of a very similar technology.[4] Therefore, no evidence is available that high entry barriers existed. Of course the brands already established might expand production and decrease prices to dislodge or dissuade newcomers in wars of attrition, although using a similar fish-canning technology. Once more, collusion should be suspected, because positive externalities from deterring new entrants benefited all the ongoing producers.

According to broader views, coming mainly from the law and economics perspective and the Chicago School, even nowadays, when courts must judge cases on entry barriers, it is difficult to distinguish right plaintiffs' claims because a counterfactual analysis would be necessary to discover ex ante marginal costs (corresponding to the non-entrance of the newcomers), and it is difficult to conclude from 'poorly discernable measurements', an argument that is absolutely true for economic historians also, because of shortage in information and sources (Demetz, 1982). It is necessary to go more into qualitative analysis, in saying that property rights, for example, legitimise entrepreneurial rights. As with brands, product differentiation is another possibility for raising entry barriers, because the greater the proliferation of brands and different products to fill ecological *niches* in the consumers' preference spaces, the less viable other entrants become (Caves & Porter, 1977, p. 248).

In Portugal, factories could produce several kinds of canned fish and added various flavours, such as salt, bay leaf, spices or even tomato, although Portuguese health authorities had a major concern about the use of tomatoes.[5] The Ministry of Public Works, Commerce and Industry declared that the tomato flavour could disguise spoiled fish, hiding the colour, the smell and the taste. A natural red coloration on the fish meant it was inadequate for canning. Should one conclude that consumers' preferences for tomato were commanding its use in product differentiation? Of course it is difficult to discern in motivation and malice situations (as suggested in law and economics perspectives: Demsetz, 1982). The Ministry of Public Works, Commerce and Industry called consumers' attention to the danger resulting from deterioration and from disguising those indicators.[6] The point is that diversifying the supplied products increases the consumers' choice as a continuum of consumption possibilities and adds some monopolistic competition to the market character, as the products are substitutes but are at the same time presented as being different products, increasing the producer's profits, as they compete in segmented markets, as industrial economics demonstrates (Schmalensee, 1978). So, the rationality for product differentiation is clear because it reduces the cross-elasticity of demand between established brands and the potential entrants' product, while it exhibits the consumers' sovereignty principle in providing a large choice for individual preferences and magnifies the role of scale economies in entry deterrence.

In all the diversified products, quality could also attain high standards. The presentation of the fish, for example, choosing an excellent arrangement of the fish in the cans with the dorsal sides exposed to obtain a blue coloured effect could become a factor. The exhibition of the fishes' bellies could also be preferred, obtaining a silvered look, as a sign of superior quality for consumers, in the domestic or foreign market. The use of olive oil always provided a superior quality. In order to achieve a high standard, it

was important to keep the oil in excellent condition. If the oil was to go rancid, all the produce would be damaged and would be unfit for consumption. Oil containers were made of iron, tin-plate or ceramics. If they were made of iron, the oil had to be consumed before rust formed. It was important to wash the containers in order to preserve the pleasing aroma of the product. Most of the olive oil for canning fish was imported. Spanish, French or Italian olive oils were frequently preferred.[7] To be a high-standard olive oil, it had to be virgin, non-greasy, thin, yellow golden, transparent, only freezing at two degrees centigrade and have acidity below one degree. All these details in ensuring quality implemented entry barriers and deterrence. In fact, although the number of canning factories increased and foreign producers joined operations to ongoing units, according to the industrial inquiries mentioned above the increase of the number of units in the overall sector of other food industries was much larger, as only 57 units are mentioned for 1880 and 10,923 for 1990. Of course the statistical quality of the inquiries must be considered, but many complaints on the handicaps of the 1890 Inquiry are also cited. The point is that not only technology, but also branding, product differentiation and product quality raised significant entry barriers in canning.

Connected businesses and vertical integration

In improving many other economic sectors, the canning industry may be seen as a sector with vertical integration opportunities. Canning stimulated both the fishing industry and olive oil production. The quality of available Portuguese olive oil in domestic and foreign markets was variable at the time. Quality depended on the virgin character of the oil, as it was sometimes diluted with other, cheaper vegetable oils, thus bringing higher revenues to those who practised this fraud. Vertical integration was difficult, however, because most Portuguese olive oils were inadequate for canning: they solidified very easily, particularly if they were cultivated in calcium-rich soils. This fact was very harmful to the fish-canning industry, as the presence of solid grease makes a bad impression when a consumer opens a can, and the scarcity of good olive oils was a common complaint. Canning thus stimulated high-standard olive oil production in the country, a food industry in itself, although Italian olive oil remained the most sought after.[8] Many problems had to be addressed. Most of the olive trees grew from plantings of branches of other trees and for this reason trees had small roots (the ideal method consisted of seeds and grafting). Furthermore, olives require a dry Mediterranean climate and several regions that were inadequate for olive oil production were planted and diseases developed on the leaves and in the fruits. Also, in most regions, ripe olives were collected from the ground after beating the trees. This method saved labour but damaged the trees, preventing them from being pruned to make them small, round and well exposed to sunshine. Moreover, the methods used to produce the olive oil were defective. Presses were scarce and olive growers had to wait, causing their olives to rot, decreasing the oil quality. Note that the introduction of the steam press was a major innovation, as it decreased the waiting time. It also allowed for control over the amount of pressure (technical recommendations pointed to a pressure of about 15 kg/cm^2 for first-class oil, and an increasing pressure on the remaining mass until 45 kg/cm^2 for second-class oil with one passage of boiling water) (Ferreira, 1905). Canners preferred the oil obtained from the first pressing, rejecting that obtained from the final mass. Technical opinions recommend that fruit should be ripe in order to minimise acidity, but not too ripe, in order to avoid rancidity (and lost fruits on the ground) (see Ferreira, 1905). So, for many reasons, international trade was a decisive aspect of raw material provision.

The stimulus of the canning industries on the production of tin-plate was also considerable. In the Portuguese case it was transferred abroad once again, as Portugal imported tin-plate for the purpose. Tin-plate resulted from the puddling of iron or steel in thin slices, to be tinned. Portuguese metallurgy could not provide enough tin-plate, but prepared it, so that it could be submitted to the high temperatures that were required for sterilisation.[9] Stamping tin-plate to imprint the trademarks was also a Portuguese industrial activity, very similar to the process of paper lithography.

Of course, vertical integration entrepreneurial strategies of the fish-canning sector with the fishing industry, to improve safety through regular raw material provision, should be an interesting managerial strategy. However, the required investment for a fishing fleet was high, particularly for the canneries with modest financial resources. This is an important topic, because only if all inputs were available in perfectly elastic supply can we assess perfect competition and market conditions for the equality of the average profit rates among producers. There is also no evidence of joint venture strategies to mitigate irregularities in the supply of fish through the participation of small firms in coalitions to extend their business to fishing. However, although vertical integration was difficult because of all the factors mentioned, it was also accomplished and must be recognised as a powerful deterrence instrument. A good example was the Portuguese Júdice Fialho, a successful entrepreneur who managed to pursue a vertical integration strategy from 1892 to 1934 (Faria, 2001, pp. 44–45). His factories canned fish caught by his own fleet of fishing vessels, which were built and serviced in his own shipyard. He also canned fruits, vegetables and meat in olive oil, all produced on his 16 farms, using cans that were made in his own locksmith workshop, and decorated in his own lithography shop to be packed in wooden crates from his own carpentry workshop (Faria, 2001, pp. 44–45). Not only did he control his business carefully and use a meticulous accounting system to promote his tremendous success, he also followed a diversified product strategy in order to minimise average production costs and maximise scale economies and profits simultaneously, coupling fish canning with agricultural production and animal husbandry (Faria, 2001, cap. III).

Labour management strategies and rational strategies on waste and environment

Although vertical integration exhibits declining average costs, it did not mean that operating at relatively small scales was impossible (Spence, 1980, p. 493). According to the 1890 Industrial Inquiry only five units had more than 100 employees, eight had from 60 to 100, another eight had from 30 to 60 and 12 had fewer than 30 (while no information is available for the remaining 19). The dimension of the units quickly improved. In 1905, in a sample of 34 factories the average number of workers was 102.[10] To minimise costs, technology and labour force strategies could be combined. The volume of production determined the number of employees, but female labour was used in most of the tasks because it was cheaper and more docile. Women began doing most of the work at the factories and this was a labour-management strategy. They even cut tin-plate, using convenient scissors. Men only soldered the cans because of their higher wages, according to their higher literacy. Historical evidence for 1905 reports a literacy rate about 35% among the male canning workers.[11] This rate is quite high in a country with the lowest literacy rate among the Mediterranean countries, which also had the lowest rates in Europe: adult literacy in Portugal was only 24% at the time (see Reis, 1988). Labour conflicts and strikes occurred mainly among soldering workers and not among the female workers. This may result from the progressive adoption of mechanical soldering in the

better-financed factories, because women could manage this challenge, using this new technology. A report says it was very difficult to introduce this new technology because of workers' opposition.[12] Any attempt to provide professional training to women was obstructed, because males could be dismissed and substituted by machines and women. Similar conflicts also occurred in other countries for the same reasons. In the USA 'Canneries were burned unless they were guarded. Attempts at assassination were nightly and sometimes daily incidents. ... Strikes continued. So did riots and burnings' (May, 1938, p. 30). Bear in mind that solderers were required in large numbers, amounting to almost 50% of the number of female workers. (Other reasons troubling the employees were the work accidents that could occur, particularly with knives and scissors. Cleaning the flayer grids, a female operation, was another dangerous activity. Once a year, at least, they had to be poured into a solution of H_2SO_4 and workers were recommended to be very careful with this operation to avoid any contact of their hands with the solution.)

However, food preserving was a creative industrial sector at the beginning of the twentieth century. Rationalised practices surely had positive effects on small firms' survival and contrary effects on entry barriers and deterrence. To minimise costs it was usual to use all the waste from the fish-canning industry to produce fertilisers. The fish waste was collected and stored in the open air, far away from inhabited places because of the smell. Some portion of $Ca(OH)_2$ was added to accelerate the decomposition into humus so that it could be used to fertilise the soil. (Setúbal, for example, had large stores of this kind of fertiliser.)[13]

Fish waste, and particularly the water used to wash the fish, could also be used to produce oils. Their uses were limited, however, because of their smell, but they were used in the soap industry and as a lubricant for ships' masts and animals' harnesses.

The tin-plate waste was spread on the ground around the fish-canning factories. It had sharp edges, but was collected in a cubic-sized wood box with sides that opened very easily, using a pitchfork. The small pieces of tin were compressed with the help of a mace. Some wires that had been placed on the bottom of the box were used to tie the compressed pieces. After removing the sides of the wooden box the cubic feet of compressed tin-plate pieces were left near the door of each factory. In the port city of *Setúbal* two men were able to accomplish this task for all the factories in the city. Each factory paid them a wage according to the number of cubic feet they left near each factory door. They moved from right to the left. When they finished the task at the left they could begin again at the right. This waste was smelted and exported and it could also be used to produce toys.[14] All these practices helped survival and histories of success offer a risk reduction to consumers.

Raw-material and other non-deterrence effects

If rational managerial practices for minimising costs could contradict deterrence effects in stimulating new entrants, abundance of raw material and international trade were powerful factors in blurring entry barriers. Given the available technology and the demand for canned fish, plentiful or scarce schools of fish on the Portuguese seacoast made all the difference for entry decision taking. The circulation of schools of fish in the oceans is still hard to predict today. For example, tuna, sardines and mackerel, which are the best species for canning, belong to the same food chain.[15] Abundance of tuna means lack of sardines, and vice versa. So if a shoal of tuna comes by your sardines you must accept the prevailing ecological equilibrium for your production scale, or even switch to canning tuna.[16]

At the beginning of the twentieth century sardines were plentiful on the Portuguese seacoast, with a better taste in the south and north-west than in the south-west. Millions of eggs left by schools of sardines in Portuguese seacoast waters assured a large population. The fishing industry could set up nets at particular spots along the shore, because, from past experience, it was known where the sardines would pass: sardines prefer dark water to escape from predators, travel from south to north in summer at a high speed and from north to south in winter at a lower speed, and do not swim parallel to the coast. As they swim in a zigzag, tackle was placed in order to catch them fleeing from the coast to the sea. If they were to take a different route, nets might be adjusted from one year to the next.

Sometimes it happens that fish disappear for unknown reasons.[17] Although fishers may take some steps to assure a good supply, many factors may be out of their control and planning becomes difficult. So, arguments that ongoing firms can choose the level of activity that new entrants will face may be not plausible in this case (for this hypothesis see Spence, 1977). Canning may suddenly be disrupted because of a lack of raw material and threatening strategies for deterrence behaviour become very difficult. Many factors may be blamed, such as seismic movements, maritime flows, or variations in water temperature; and oceanographic studies were not well enough developed to foresee the fluctuations of fish circulation in the seas. Since 1880 schools of sardine had disappeared from the French coast. At first it was thought that it was because of the extremely cold winter of the previous year, but soon the canning firms discovered it was a permanent disappearance, from 1902 on. This is the reason why French canning entrepreneurs moved into Portugal. Émile Louis Roullet, the founder of the firm Société Générale Française, was delocalising his activity. This means that by then no excess capacity existed in the market to represent an entry-discouraging situation for foreign direct investment and Portuguese firms had no unused production capacity to be a credible threat in price warfare against a new entrant. So, more abundant raw material in Portuguese waters and high international demand for canned fish had opposite effects to other possible elements favouring deterrence attempts (Schmalense, 1981). The sector is a real case study of contradictory effects. According to the 1890 Industrial Inquiry the foreign newcomers were the largest units: Roulet employed 160 workers, F. Delany 88, Frederic Delary 72, J. Labrouche 86, Pélier Frères 78 and Parodié 125, which confirms that entrants planned their plants. According to Stigler (1968) and Demsetz's (1982, p. 56) views, newcomers and established producers are 'two combatants on equal foot'.

The situation post-entry may even be described as a non-cooperative duopoly made of the previously established firms and the newcomers, as all of them were profit maximisers (Dixit, 1980). Although total industrial production is unknown, exports may be used as a proxy to account for the short-run production fluctuations. As expected, and although the long-run trend was increasing from 1889 to 1903, strong annual fluctuations occurred, between 5000 and 15,000 tons, as Figure 2 shows. (Of course the fluctuations of the monetary value of these exports were smoother than the fluctuations of the exported quantity, because of compensatory variations of prices in the world market and, in one way or another, canned fish exports were a relevant item in the Portuguese trade balance, almost tripling from 1889 to 1904.)[18]

It was possible to fish in deep waters, far from the coast, since international laws were respected, but fisheries ran into trouble if they fished far away from the coast, because the catch did not stay fresh. The only solution, both for ongoing producers and new entrants, was to begin the canning process at sea, which is to say, to transform the ships into factories. This was the trend for fishing technologies in the second half of the twentieth century. However, at the time this was impossible, and even now there is not enough space aboard ships for canning, but only for freezing. To sum up, fish canning faced many

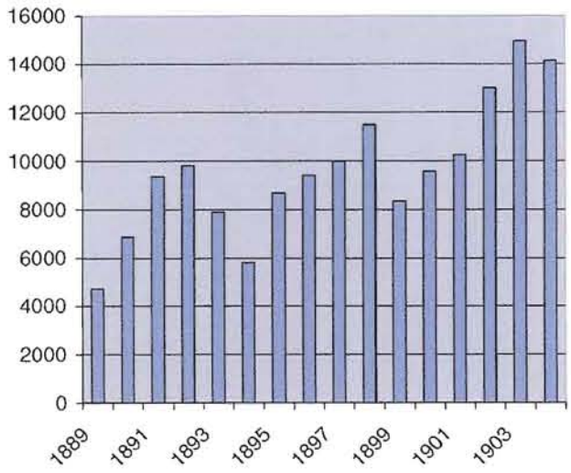

Figure 2. Exports of canned fish (tons).
Source: *Estatísticas do Comércio Externo*, issues from 1889 to 1904.

uncertainties, which meant it was very risky, making entrepreneurs aware of unavoidable fluctuations. To compensate for the risky situation resulting from annual variation in raw material provision, some firms diversified their business and embraced other food-canning activities. Some factories preserved vegetables, tomato and peas, as well as meat.[19]

The preferred meat was veal, pork, rabbit, chicken and turkey. It was cleaned, cut and roasted. Pork-canning required lard. In the case of meat preserves, beautiful depictions of animals decorated the cans. The systems to preserve vegetables, tomato, fried slices of large fish in a sauce, and peas also consisted of a slightly salted boiling method. As with fish preserves, they were also arranged in tin cans and sterilised under high temperatures.[20] This managerial strategy may have resulted from decreasing market shares after the newcomers' entrance and may be identified with seasonal maximisation of available production capacity.[21]

It is useless to judge Portuguese producers or foreign newcomers. They all defended their businesses. In contributing to fight scarcity of food, they increased social welfare. Canning advanced the food consumption for making possible the smoothing of consumed portions of highly perishable and seasonal goods throughout the year. They even provided delicious delicacies and made them available throughout the year. Even deterrence behaviour has positive effects in product innovation and quality. Refrigerator systems of the twentieth century did not put an end to their production, since they achieved high profiles and the consumers' preferences.

Conclusion

Technology and equipment might put in motion deterrence effects and economies of scale seem to have worked as entry barriers, although a less than perfect coordination among ongoing producers made possible the entrance of foreign firms. The availability of resources made it possible to look for international comparative advantages and specialisation in order to be competitive in the world market. More than investing in plants, entrepreneurs preferred branding and advertising as a real investment in preserving market share, because of the effects on demand and on consumers' loyalty. Although

trademarks had a worthwhile effect in making consumers rely on firms' experience and reputation, these effects were blurred by international trade and foreign markets because existing producers did not prevent foreign newcomers, and some of the entrants were European firms delocalising their activities but having their own established brands in their domestic markets or even in the global market. Legal entry barriers would only be created in the context of the Great Depression, when economic nationalism became the global environment for protectionist policies.[22]

Although canning fish was a very risky sector from an entrepreneurial point of view, it was also an important economic sector in providing jobs because of its labour-intensive technologies. Its stimulus carried over not only to the fishing industry, but also to cattle-raising and food production in general, as well as metallurgy and lithography. The Portuguese canning sector is an illustrative case of considerable uncertainty and contradictory effects of managerial abilities in deterrence behaviour and capacity to raise entry barriers.

Acknowledgements

I am grateful to the Portuguese *Fundação de Ciência e Tecnologia* and to the *Fundação Luso-Americana* for their financial support to this work. I thank John Huffstot for correcting my English and Duarte Valério for the map. Any errors are mine.

Notes

1. These industries formed a class of their own (number 62) in the classification of economic activities used at the time.
2. This factory was in Setúbal. On the role of American female canners see May (1938, pp. 307–317).
3. In many European countries, mid-nineteenth-century laws removed many obstacles to foreign investment. In Portugal, a law on June 22, 1867, regarding joint stock companies, which was imbued with liberal principles, brought freedom to the constitution of Portuguese joint stock companies. Even so, foreign joint stock companies were required to obtain an authorisation licence from the Portuguese government to carry on business in Portugal.
4. The report included 21 steam machines, 53 tables for soldering, 35 drying chambers, 51 scissors for tin-plates, 56 sterilising containers, 34 weather vanes, 120 logs, 7 containers for chopped tomatoes, 31 hoists and cranes, 96 shapers, 21 scissors, 68 drawing frames, 90 knives, 12 drills, 81 screw presses, and 162 furlers and lappers. Archive of the Portuguese *Ministério das Obras Públicas, Comércio e Indústria, Sociedades Estrangeiras.*
5. For example, trademarks such as Sardinha Brandão Gomes, from Brandão Gomes & C^{a}, with a main factory at Espinho and branch at Matosinhos produced sardine 'in olive oil', 'in superior olive oil', 'with pepper', 'in brine', 'fried', and 'with lemon', 'in butter' and 'in pickles'.
6. *Boletim do Trabalho Industrial (n°2), Ministério das Obras Públicas, Comércio e Indústria*, 1905.
7. According to the Industrial Inquiries, *Inquéritos Industrias*, 1880 and 1890 (volumes 3, 4, 5).
8. The *Boletim do Trabalho Industrial (n°2), Ministério das Obras Públicas, Comércio e Indústria* mentions that Spanish olive oil was frequently fake or at least adulterated.
9. A good example is provided by the French metallurgical society (Société Métallurgique de Setúbal), operating in the port city of Setúbal.
10. According to *Boletim do Trabalho Industrial* (no. 2) in the districts of Lisbon and Leiria there were 34 factories of fish canning in 1905 employing 3072 people, 1760 were women and 1312 men. This means an average of 102 workers.
11. In the sample mentioned in note 10, among 1312 male workers, 461 were literate, that is to say 35%. No statistics are available for female workers.
12. By the head engineer of the 'Third Circumscription for Portuguese Techniques for Industry' Luís Feliciano Marrecas Ferreira, 3^{a} *Circunscrição dos Serviços Técnicos da Indústria.* In a sample of 2516 workers, 756 were solderers and 1760 female workers.
13. And Lisbon had one, the Pereira Lima fertilisers. Fertiliser was sold at a price about £3.1/ton ($15/ton or 14 milreis/ton).
14. Tin-plate waste was sold at the price of £2.7/ton (about $13/ton or 12 milreis/ton).

15. Another way of preserving fish was salt drying. It required dry weather, high natural temperatures and wind. Few regions in the world can provide such natural conditions. In Portugal only the Southern coast under African desert winds could provide the conditions. Drying chambers were the technical solution used. Salted fish was sliced first to speed the drying process. In Portuguese colonies, the port city of Moçâmedes in Angola had excellent conditions, because of the proximity to the desert of Moçâmedes.
16. May (1938, pp. 190–196) tells how tuna turned from sport to diet in the USA by 1909.
17. This phenomenon was well known on the Southern coast.
18. They increased from 565 contos to about 1400 contos. Brazil and Latin American countries were important outlets.
19. A. Leão & C^{a}, in Almada, and *C^{a} Nacional de Conservas* in Alcântara, Lisbon, for example.
20. Historical evidence refers to Elvas, Almada, Lisbon and Setúbal as the main cities with operations canning vegetables, tomato and peas. The main factory was the Portuguese firm Frederico Ferreira Mariz in Setúbal.
21. Preserving fruit was a seasonal activity. The peak of the crop occurred during two or three weeks in the summer under high temperatures. As there were no refrigeration methods, the preservation had to be achieved before spoiling.
22. The so-called *Condicionamento Industrial*.

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